2.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

2.1 DOE'S PURPOSE

DOE, in partnership with its stakeholders, supports efforts by industry to improve electricity reliability and energy security in the United States. The purpose of this AHPC project is to demonstrate technology capable of improving the performance of existing and new coal-fired electric power plants. Improved performance includes increasing the efficiency of electric production, reducing environmental impacts, and improving the cost-competitiveness of coal-fired power generation.

Particulate emissions control, a component of the NETL Environmental and Water Resources Product Line*, seeks to develop cost-effective control technology for: (1) primary fine particulates and associated trace metals (e.g., lead, arsenic, etc.); (2) gaseous precursors that react in the atmosphere to form secondary fine particles; and (3) acid gases (e.g., H_2SO_4, HF, and HCl) that can create visible plumes and are reportable under the Toxic Release Inventory.

To comply with current particulate emission limits, the majority of coal-fired electric utility boilers control primary particulates with electrostatic precipitators (ESPs), which use electric fields to remove particulates from boiler flue gas. A smaller, but growing, number of boiler operators uses fabric filter collectors (baghouses). Baghouses control particulate matter by passing the flue gas through a tightly woven fabric, which collects the particles in the form of a dust cake. When operating properly, ESPs and baghouses can achieve overall collection efficiencies of 99.9% of primary particulates (over 99% control of PM_{10} and 95% control of $PM_{2.5}$), which is below the 1978 New Source Performance Standard (NSPS)-required limit of 0.03 lb/million Btu. In addition, a high level of trace element removal usually accompanies high efficiency particle collection because, with the exception of mercury and selenium, the trace elements are typically associated with the particulate phase.

However, even with high performing particulate control systems, submicron particle size collection is less efficient. Particles in the 0.1 to 0.5 micron size range pose an especially challenging control problem for stationary sources that employ wet scrubbers and ESPs. In addition, ultra-fine (less than 1 micron) particulate matter can be comprised of trace metals and other suspected hazardous air pollutants (HAPs). Moreover, more than half of the existing population of ESPs installed on electric-utility boilers in the United States have been in operation for more than 30 years, with almost 17% historically operating for at least 40 years. The increased age of these ESP systems has led to decreased particulate collection efficiency. Current control projects are chosen on the basis of the need for technology to improve the efficiency of particle collection in the ultra-fine size range, and to develop retrofit technologies to enhance the performance of existing ESPs that are not achieving acceptable overall efficiencies.

The specific performance target for technologies, processes, and concepts directed at the control of primary particulate matter is 99.99% capture for all particle sizes ranging from 0.01 to 10 microns and an emissions rate not to exceed 0.01 lb/million Btu. Advanced systems must be capable of meeting these stringent compliance requirements while achieving a levelized cost savings target of at least 25% over

* **The Environmental and Water Resources Product Line** is focused on the development of highly efficient and cost-effective environmental control technologies for retrofitting to existing power plants, with application to new plants as well. The Product Line also provides key scientific and technical data on emerging environmental regulatory and policy issues.

conventional state-of-the-art controls (i.e., ESPs and baghouses). Levelized cost is based on uncontrolled particulate matter levels and includes the total cost of all particulate control systems required to achieve the specified performance targets.

Based on pilot-scale data, AHPC technology not only achieves an ultra-high collection efficiency for fine particles, but also uses resources more efficiently. AHPC technology can be applied to older, high-emission plants to attain current standards, but is also capable of meeting more stringent environmental goals. During pilot-scale tests, the AHPC concept demonstrated better than 99.99% fine-particulate capture and achieved control of particulate-phase air toxics that were concentrated in submicron particles. In addition, AHPC appears to qualify as a technology for "zero emission" boilers for the 21^{st} century. The vapor phase component of air toxic metals (primarily mercury) would not be captured by the AHPC unless an effective sorbent was available. Sorbent development is not an objective of the proposed demonstration. However, previous data indicate that vapor phase trace metals can be effectively captured with sorbents in an AHPC system without impairing performance.

In general, retrofitting or designing new electric utilities with advanced particulate collection technologies, such as the AHPC, would provide a number of benefits that have the potential to increase electric performance and output in the United States. In a retrofit scenario, such as proposed by Otter Tail Power, the electric generating station would have a much greater flexibility in the selection of coals with out derating the plant because of opacity requirements. In this way, a utility may be able to supply more power over a longer period of time. For construction of a new plant, the overall permitting process may become easier if the utility is able to assure the public and permitting agencies that emissions would be very low, even for the finest particles.

2.2 DOE'S NEED FOR ACTION

Currently, coal-fired electric utility boilers built or modified after August 17, 1971, must comply with a New Source Performance Standard (NSPS) limit on primary particulate emissions of 0.10 lb/million Btu. Units built or modified after September 18, 1978, must comply with a more stringent standard of 0.03 lb/million Btu, or 1 percent of the potential combustion concentration (99 percent reduction). Average primary particulate emissions from coal-fired utility boilers are about 0.043 lb/million Btu. Airborne particles are also regulated as "criteria pollutants" under EPA's National Ambient Air Quality Standards (NAAQS) program, so the emissions of primary PM_{10} (particles smaller than 10 micrometers) and $PM_{2.5}$ (particles smaller than 2.5 micrometers) from coal power plants are also subject to limitations set forth under State Implementation Plans (SIPs) for achieving the ambient standards for these pollutants.

<u>Impact of $PM_{2.5}$ NAAQS Regulations</u>

Although most of the primary particulate matter produced by coal-fired power plants is captured by existing pollution control devices, the portion that does escape falls primarily into the $PM_{2.5}$ size category, as does almost all of the secondary particulate matter formed from SO_2 and NO_x. EPA promulgated new ambient standards for $PM_{2.5}$ in July 1997. The schedule for implementing the $PM_{2.5}$ standards requires the collection and analysis of data from a nationwide ambient monitoring network through 2003. Contingent upon the outcome of a five-year scientific review of the standards to be completed in 2002, EPA plans to designate non-attainment areas starting in 2002 and ending by 2005. States that contain areas that are not in compliance with the standards will be required to submit SIPs by 2008; full compliance with the $PM_{2.5}$ NAAQS will be required by 2017.

Opacity

Opacity created by the combined gas/particle releases from the coal-fired electricity generating units is regulated under the same section of NSPS that restricts the emission of particulate matter (40 CFR Chapter I, Part 60, Subpart D, Section 60.42 and 60.42a). All units built or modified after August 17, 1971, are prohibited from releasing any gases that exhibit greater than 20 percent opacity (6-minute average), except for one 6-minute period per hour of not more than 27 percent opacity.

Opacity in coal-fired utility boiler exhaust streams can be caused by many factors, including primary particulate matter escaping the particulate collection system, particles generated in flue gas desulfurization systems downstream of the primary particulate control device, condensable aerosols such as sulfuric acid in the flue gas, secondary particulate matter formation, and colored gases such as NO_2. Thus, some units can violate the opacity standard while still meeting the particulate matter emission standard. Development of appropriate control technologies would depend on accurate identification of the actual source(s) of stack opacity, which would be facilitated by use of AHPC technology.

2.3 DOE'S IMPLEMENTATION INITIATIVE

In response to the National need for assuring abundant and affordable electricity supplies, DOE initiated the "Power Plant Improvement Initiative," a precursor to the President Bush's Clean Coal Power Initiative, to develop leading edge clean coal technologies capable of improving the reliability and environmental performance of the Nation's 'coal-burning power plants. The U.S. Congress strongly supported the initiative as an approach to address intermittent electrical power supply disruptions and price increases. Funds were identified for supporting projects to improve the performance of existing and new coal-fired electric power plants. To establish such projects, the "Power Plant Improvement Initiative" was initiated through a competitive solicitation (DE-PS26-01NT41104) to identify showcase projects for demonstrating the ability of coal-fired plants to generate low-cost electricity while achieving improved performance and compliance with stringent environmental standards.

One objective of the solicitation was to demonstrate new approaches for achieving very high levels of capture for fine particles, while providing high reliability, smaller size, and economic benefits. In response to the solicitation, Otter Tail Power Company submitted a proposal entitled "Demonstration of a Full-Scale Retrofit of the Advanced Hybrid Particulate Collector." Otter Tail Power and its partners, Montana-Dakota Utilities and NorthWestern Public Service, proposed to retrofit Advanced Hybrid Particulate Collector (AHPC) technology into an existing electrostatic precipitator (ESP) at the Big Stone Power Plant. The application from Otter Tail Power was selected for negotiations leading to award of a cooperative agreement with specific objectives to demonstrate ultra-low fine particulate emissions, low pressure drop, overall reliability of the technology, and long-term bag life.

The AHPC is a perfect match to this objective. The AHPC is also well-matched to boilers using any U.S. coal. High levels of SO_3 or HCl in the flue gas from any high-sulfur bituminous fuel would not be a problem. Similarly, emissions would not be significantly affected by ash resistivity. For very high ash coals, which is typical of some lignites, the AHPC is capable of handling extremely high dust loadings.

2.4 OTTER TAIL POWER COMPANY'S NEED FOR ACTION

Installation of AHPC technology at the Big Stone Power Plant would improve the overall reliability of the air pollution control system. For example, **Table 2-1** shows the derates that have occurred at the Power

Plant because of maintenance and resistivity problems associated with the ESP.

Table 2-1. Derates at the Big Stone Power Plant Due to ESP Problems

YEAR	OPACITY DERATES, MWH*	ESP REPAIR DERATES, MWH	TOTAL DERATES, MWH
1999	7,786	16,004	23,790
2000	6,859	16,676	23,535
* Megawatt hours.			

Although no immediate need exists for improving particulate control at the Big Stone Power Plant, the project is attractive to Otter Tail Power Company for the following three reasons.

The internal components of the existing precipitator at the Big Stone Plant are beginning to fail at an unacceptable rate, which requires that the plant reduce electrical output and isolate certain sections for repair. The AHPC would replace failing electrodes and rappers, which cause an increase in emissions and reduced electrical output.

Otter Tail Power Company takes pride in being involved with projects that look to the future. Although the current particulate control device performs at levels acceptable under environmental regulations today, the AHPC would place the Big Stone Plant in a better position to meet future regulations for fine particulate control.

A successful demonstration of the AHPC project at the Big Stone Power Plant would strengthen Otter Tail Power Company's strong commitment to Environmental Stewardship. The operators of the Big Stone Plant have emphasized environmental stewardship and the importance of being a good neighbor to the surrounding communities. Although the Big Stone Plant has met all particulate control and air permit requirements by the State of South Dakota, a primary fuel switch in 1995 to Powder River Basin (Wyoming) subbituminous coal caused the average opacity to increase and created a "dirty" appearance of stack discharges at certain times. Installation of the AHPC would remove fine particulates, which are difficult to collect, and reduce emissions that contribute to flue gas visibility.

Table 2-2 identifies the proposed participants in the project and their respective responsibilities and interests in the proposed project.

2.5 DOE DECISION

The decision to be made by DOE is whether to provide approximately 49% of the estimated $13.4 million cost for installation and demonstration of a full-scale Advanced Hybrid Particulate Collector at the Big Stone Power Plant.

2.6 SCOPE OF THE ENVIRONMENTAL ASSESSMENT

Based on the activities that would be conducted for installation of the AHPC system and the potential changes that would result from operation, the following environmental resources were considered to merit primary emphasis during analysis of the potential environmental consequences of the proposed action: air, noise, site infrastructure, transportation, waste management, socioeconomics, and cumulative impacts.

Safety and health impacts would be limited to potential accidents and environmental releases that could affect workers and the public. All personnel and contractors that would participate in construction and operation of the proposed AHPC system would be responsible for compliance with applicable Occupational Safety and Health Administration regulations concerning occupational hazards and protective measures for employees.

Table 2-2. Project Participants

PARTICIPANT	RESPONSIBILITY	OBJECTIVE(S)	COST SHARE
Otter Tail Power Company	Part owner of the Big Stone Power Plant and operator of the AHPC system	Improve reliability and environmental operations at the Big Stone Power Plant	51%
Montana-Dakota Utilities	Part owner, with Otter Tail Power and NorthWestern Public Service, of the Big Stone Power Plant	Improve reliability and environmental operations at the Big Stone Power Plant	-
NorthWestern Public Service	Part owner, with Otter Tail Power and Montana-Dakota Utilities, of the Big Stone Power Plant	Improve reliability and environmental operations at the Big Stone Power Plant	-
W.L. Gore and Associates	Supply particulate collector bags for use in the AHPC system and periodically determine performance and wear	Demonstrate market application of Gore's particulate collection bags	-
ELEX AG	Design and construction of the AHPC system		-
Univ. of North Dakota, EERC	Consulting services on the AHPC technology and plant sampling to determine particulate removal efficiency		-
U.S. Department of Energy	Co-fund design, construction, and initial operation of the AHPC system	Demonstrate an advanced particulate control technique for capture of ultra-fine particles in a full-scale commercial operation	49%